Digitizing and Delivering Audio and Video

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IU Digital Library Program

Digital Library Brown Bag Se s
February 11, 2 5

Some questions to ask when starting a project

- What is the purpose of digitization?
  - Preservation/archiving
  - Delivery to users: network, CD-ROM, DVD
  - Both
- Who are the users and what is the use?
  - Affects quality requirements
- Where are the users?
  - Network bandwidth
- How will they get to the content?
  - Metadata, searching, browsing

Presentation Outline

- Digitization and capture
  - Audio
  - Video
- Delivery
- What's going on at IU?
  - Available digital audio/video services
  - Digital library projects involving audio/video

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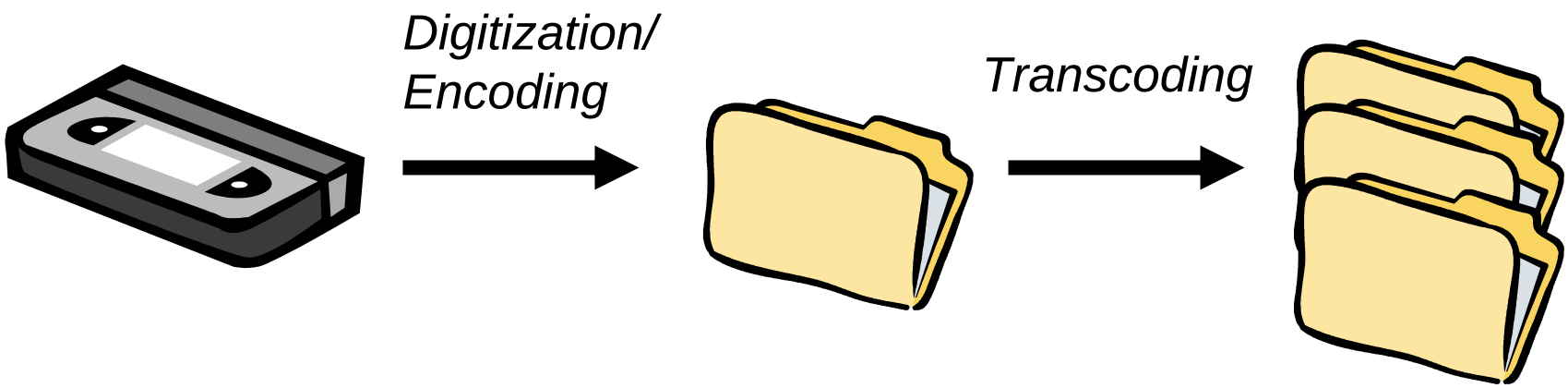
Typical Audio/Video Workflow



Source

Master file

Editing/cleaning possible

Compressed derivative files for delivery

Tools for Digitization

- Computer workstation
- Audio/video source equipment
  - VCR, tape deck, turntable, etc.
- Analog-to-digital converter
  - May be internal or external (connected to computer via USB or Firewire)
  - Wide range of quality: consumer, professional
- Audio/video editing, compression software
  - Audio examples: Sound Forge, Bias Peak
  - Video examples: Adobe Premiere, Apple Final Cut Pro, Apple iMovie

Audio: Source Formats

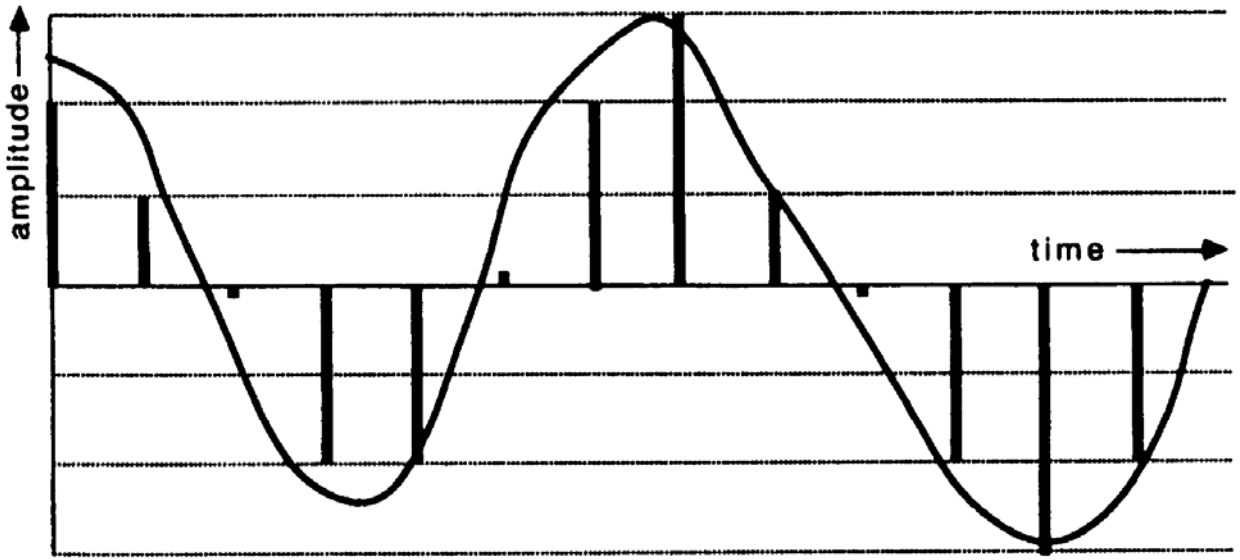
- Analog
  - Discs: LPs, 78s, etc.
  - Tapes: open reel, cassette, 8-track
  - Other: wire recordings, cylinders
- Digital
  - Discs: CD, DVD-Audio
  - Tapes: DAT, ADAT

Digital Audio Basics

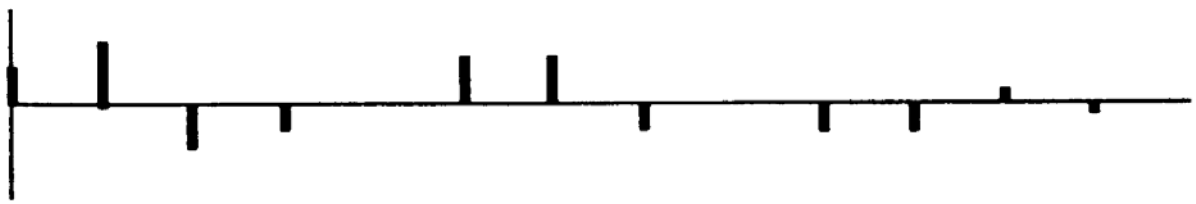
- Sampled waveform
  - Pulse code modulation, or PCM
- PCM characteristics which determine quality
  - Sample rate (hertz)
    - Determines frequency range reproduced
    - Sample rate = 2 * frequency range (Nyquist)
  - Sample size (bits)
    - Larger sample size = less quantization noise
  - Number of channels

Digital Audio: Sampling

audio sampling



quantization noise



Barlow, *Multimedia Systems*, p. 77.

CD Audio

- Sample rate:
  - 44.1 kHz (44,100 samples/second)
- Sample size:
  - 16 bits
- Number of channels:
  - 2 (stereo)
- Bitrate
  - 44100 samples/second * 16 bits/sample * 2 channels = 1.4112 megabits/second

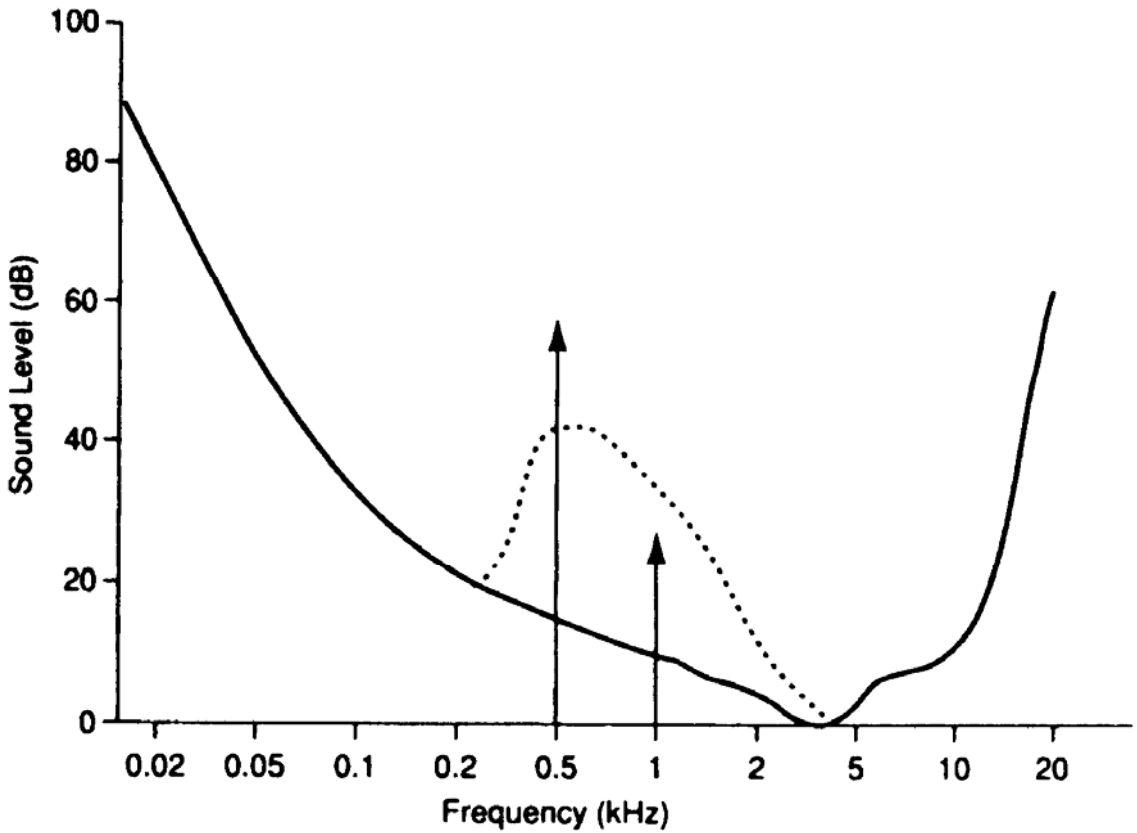
Master Audio File Formats

- Two main formats (actually many more)
  - WAV (Microsoft/IBM)
  - AIFF (Apple)
- All essentially interchangable
  - Header + sample data
- No true standard (i.e. ISO standards process) in common use
- WAV is defacto standard
- Broadcast WAV gaining use

Audio Compression

- Most audio compression schemes for music are lossy, based on ‘psychoacoustic’ techniques
  - Based on understanding of human hearing and audio processing
- Masking principle
- Subband coding

Audio Compression: Masking Effect

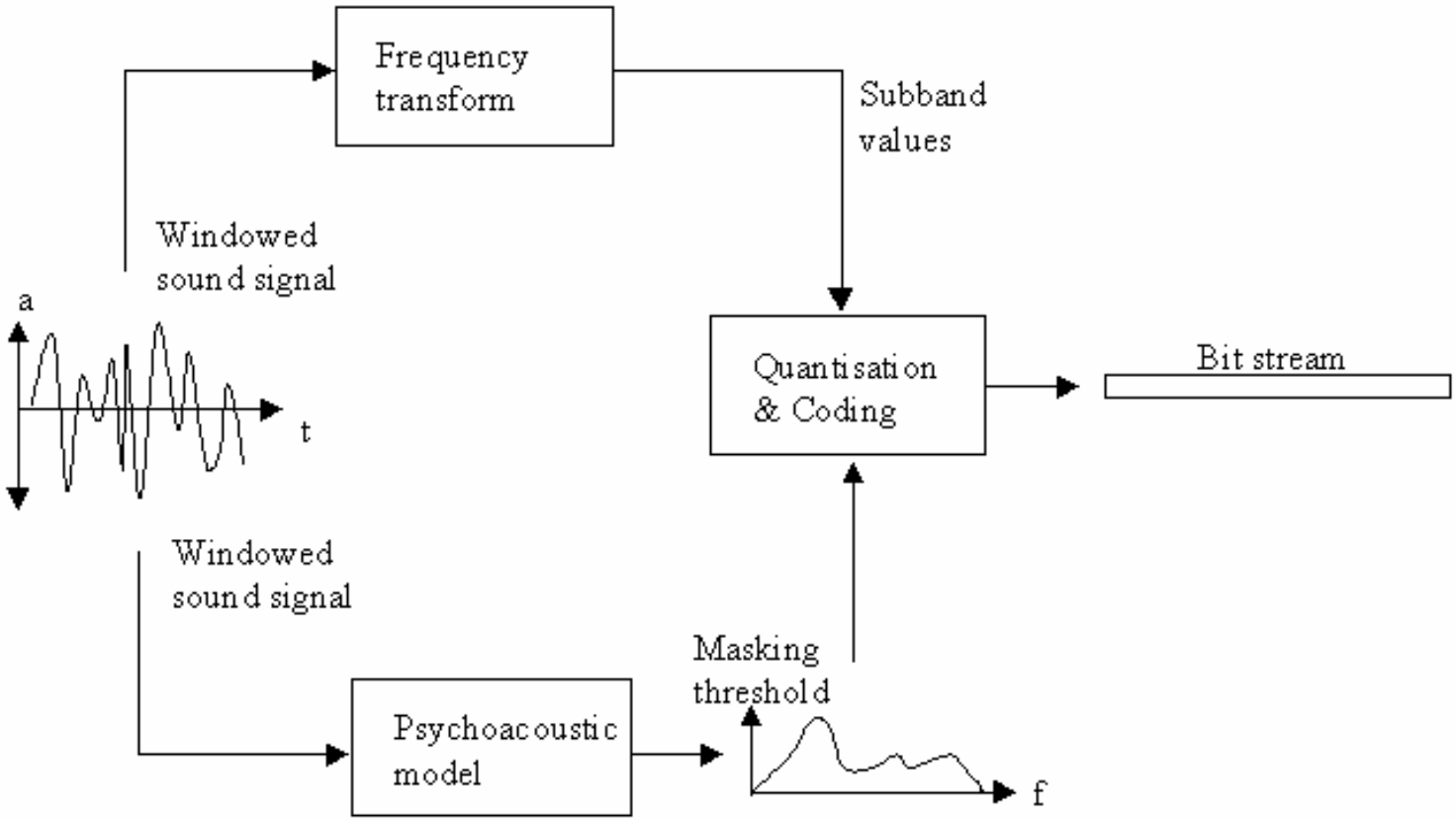


Barlow, *Multimedia Systems*, p. 73.

Audio Compression: Standards

- MPEG-1
  - Layers 1, 2, and 3 (‘MP3’)
  - Typically 128-384 kilobits/second (for stereo)
- MPEG-2
  - Layers 1, 2, and 3 and AAC (Advanced Audio Coding)
  - Typically 96-384 kilobits/second (for stereo)
- MPEG-4
  - Improved AAC
  - Synthetic audio
  - Low bit rate parametric audio

MPEG-1 Audio Compression



From the MPEG Audio FAQ
http://www.tnt.uni-hannover.de/project/mpeg/audio/faq/

Audio Compression: Proprietary Formats (Codecs)

- QDesign Music
  - Used with Apple QuickTime
- RealAudio
  - Used with RealPlayer
- Windows Media Audio
  - Used with Windows Media

- *Codec:* compressor/decompressor

Video: Source Formats

- Analog
  - Tape: VHS, Betamax, 8mm, Hi8, Umatic, Betacam SP
  - Disc: Laserdisc, SelectaVision :-)
- Digital
  - Tape: MiniDV, Digital8, DVCAM, Digital Betacam
  - Disc: Video CD, DVD

Video is just like a series of still images, right? No.

- Scanned images
  - Represented as grid of Red-Green-Blue values
  - Master images are uncompressed, lossy compression used for derivatives
  - See Jenn's Fall 2003 Digitization of Photographs brown bag presentation for more info

Video is somewhat like a series of still images

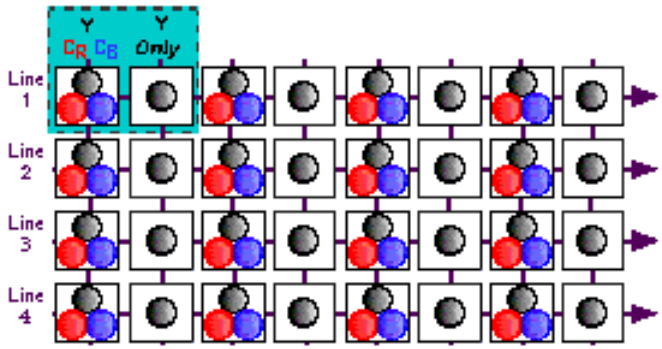
- Video uses Red-Green-Blue color space
- Pixel resolution (width x height), number of bits per pixel, and frame rate are factors in quality
- But there’s much more to it...

Digital Video Basics

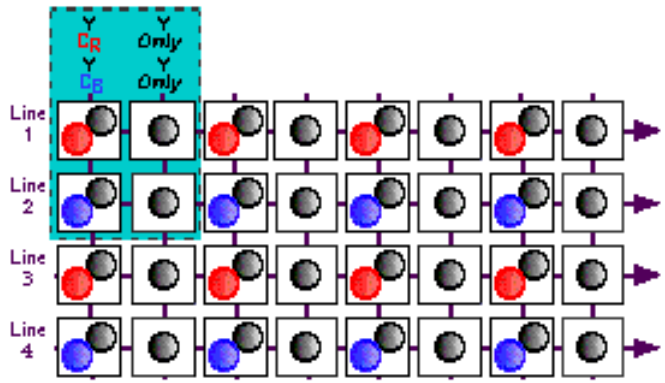
- A video signal consists of luminance and chrominance information
- Luminance – brightness, varying from white to black (abbreviated as Y)
- Chrominance – color (hue & saturation), conveyed as a pair of color difference signals:
  - R-Y (hue & saturation for red, without luminance)
  - B-Y (hue & saturation for blue, without luminance)
  - Where's the green?

Digital Video Basics

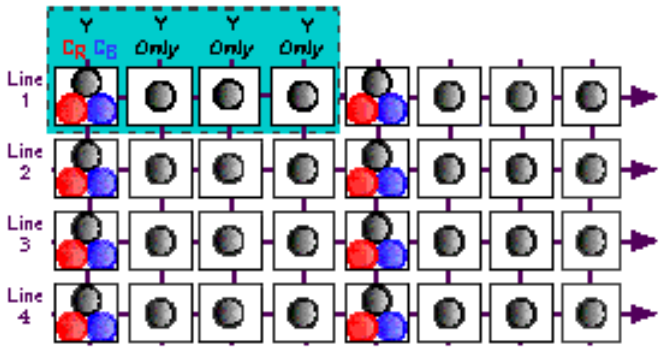
4:2:2 sampling



4:2:0 sampling



4:1:1 sampling



4:2:2 – High End DV (Digital Betacam, DVCPro50)

4:2:0 – MPEG 1 & 2

4:1:1 – DV and DVCAM

Digital Video Basics: Scary Math

- Why not 4:4:4 sampling?
  - 720 x 486 resolution = 349,920 pixels per frame
  - 349,920 pixels x 10 bits/sample x 3 samples/pixel = 10,497,600 bits per frame
  - 10,497,600 bits/frame X 29.97 frames/second = 314,613,072 bits per second
  - 314,613,072 bps x 3600 seconds = ~141.58 GB/hour
  - For 1920x1080 HDTV, more like 840 GB/hour
- 4:2:2 sampling drops that rate by a third with almost no perceptible difference in quality.
- 4:2:0 and 4:1:1 drop it in half
  - about 70 GB/hour for normal resolution video

Digital Video Compression

- 70 GB per hour (155 Megabits/second) 4:2:0 video is still big and expensive
- Additional compression techniques
  - Downsample from 10 bits/sample to 8 bits/sample
  - Use typical image compression techniques (like JPEG)
  - Interframe compression
- MPEG-2 Compression
  - Good quality: 50 Megabits/second, no interframe compression
  - Typical (DVD, cable box, satellite): 6-12 Megabits/second

Master Video File Formats: No Good Choices

- Lossy
  - MPEG-2
  - DV
  - Motion JPEG
  - Motion JPEG2000
- Lossless
  - QuickTime “Raw”
  - Motion JPEG2000

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Downloading

- User must wait for the entire file to transfer before viewing any part of it
- Seeking within the file almost immediate
- User gets the entire file, and can use it in any way they choose
- Quality is dependent on how long you're willing to make your users wait for the file to download

Streaming

- File transferred to user in small parts, can view once the first part has been delivered
- Seeking within the file requires communication with the streaming server and a delay while a new chunk of the file delivered
- User does not receive a complete re-usable copy of the file
- Quality dependent on the network bandwidth between the user and the streaming server

Streaming media players

- QuickTime
  - Limited in codecs it can play back
  - Comes with Mac operating systems
  - No version for Unix/Linux
- RealPlayer
  - Limited in codecs it can play back
  - Free version hidden on download site
- Windows Media Player
  - Limited in codecs it can play back
  - Comes with Windows operating systems
  - No version for Unix/Linux
  - Latest version not released for Mac

Streaming servers

- Apple QuickTime/Darwin Streaming Server
  - Open source (free!), uses open standards
  - Streams QuickTime and MPEG-4 content
- RealNetworks Helix Universal Server
  - Expensive, proprietary
  - Streams Real, Windows Media, MPEG, and QuickTime content
- Microsoft Windows Media Services
  - Free with Windows Server, proprietary
  - Streams Windows Media content

Other forms of delivery

- Tethered download
  - DRM in effect
  - iTunes, for example
- DVD
  - uses MPEG-2
  - ease of distribution

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Digital audio and video services at IU

- DLP
- DMNS
- DMS
- TLTC
- Radio/TV Services

Digital Library Program (DLP)

- Can handle these formats:
  - VHS
  - DVD
  - Laserdisc
  - CD
  - Cassette
  - Open reel tape
  - DAT
  - LPs
- Digitization and consulting services as part of the Digital Media and Image Center (DMIC)
- Contact: Kara Alexander, Digital Media Specialist, kalexand@indiana.edu

Digital Media Network Services (DMNS)

- Division of UITS
- Hosts IU streaming media servers
- Service is free for IU academic and administrative units
- Can stream Real, QuickTime, and Windows Media content
- http://www.indiana.edu/~video/
- video@indiana.edu

Digital Media Services (DMS)

- Division of UITS
- Digitization and derivative creation services for still images, audio, and video
- System-wide service, based in Indianapolis
- For-fee service
- http://dms.iu.edu/
- iudms@iu.edu

Teaching and Learning Technologies Centers (TLTC)

- Sponsored by:
  - Office of Academic Affairs
  - Office of the Vice President for Information Technology
- "Provides *consulting* and *development* for integrating technologies into university teaching and learning."
- http://www.indiana.edu/~tltl/
- tltc@indiana.edu

Radio/TV Services

- Audio and video digitization in support of public radio and public television production services
- Performs digitization for campus units for a fee
- Contact: Scott Carmichael, sacarmic@indiana.edu

VARIATIONS
Digital Music Library

- Online since 1996
- Master audio file format:
  - CD-quality WAV (stored in MDSS)
- Delivery audio format:
  - MP2 (MPEG-1 layer 2) @ 384 Kilobits/second
- Streaming:
  - IBM VideoCharger server
- http://www.dlib.indiana.edu/variations/

Variations2 Digital Music Library

- NSF-funded research project evolving into production system for summer 2005
- Need to convert 10,000+ hours of audio from VARIATIONS
- Master audio file format:
  - CD-quality WAV
- Delivery audio formats:
  - MP3 (MPEG-1 layer 3) @ 192 Kilobits/second
  - MPEG-4 AAC @ 32 Kilobits/second
- Streaming:
  - Apple QuickTime Streaming Server
- http://variations2.indiana.edu/

EVIA Digital Archive

- Ethnomusicology field video
- Master file formats:
  - MPEG-2 @ 50 Megabits/second
  - Digital Betacam tape at ATM (not really a file!)
- Delivery file formats:
  - MPEG-2 @ 8 Megabits/second (on-campus, Internet2)
  - MPEG-1 @ 1 Megabit/second (on-campus, Internet2)
  - MPEG-4 @ 300 Kilobits/second (cable, DSL)
- Streaming:
  - Apple QuickTime Streaming Server
- http://www.indiana.edu/~eviada/

Video E-Reserves Project

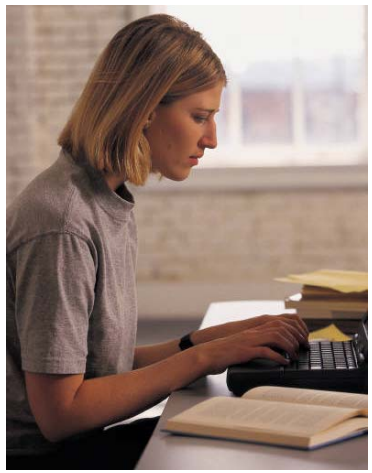
- Pilot tests performed Spring 2004 (2 classes) and Fall 2004 (5 classes)
- Classes chosen for high enrollment and need to view videos outside of class
- Pilots covered VHS and DVD
- Digitization and transcoding performed in DMIC
  - 2 videos in Fall 2004 sent to DMS for comparison

Video E-Reserves Workflow

- Master file
  - MJPEG-A @ 10 Megabits/second
  - Master file not kept after streaming files created and checked
- Delivery files
  - MPEG-4 and RealVideo @ 1 Megabit/second
  - MPEG-4 and RealVideo @ 300 Kilobits/second
  - MPEG-4 and RealVideo @ 100 Kilobits/second
  - MPEG-4 and RealVideo @ 40 Kilobits/second
- Streaming:
  - Apple QuickTime Streaming Server
  - RealNetworks Helix Universal Server

Video E-Reserves Access

UITS Streaming Servers



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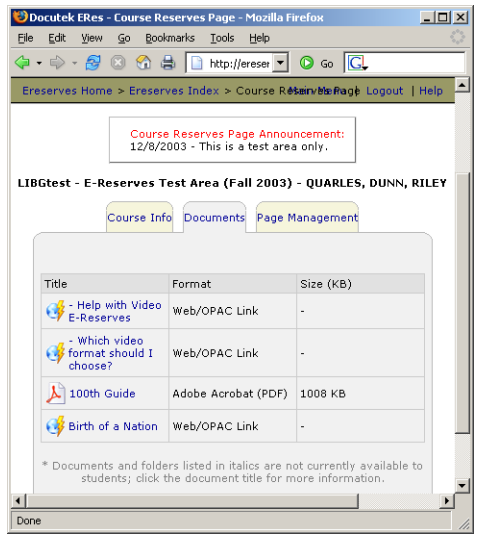

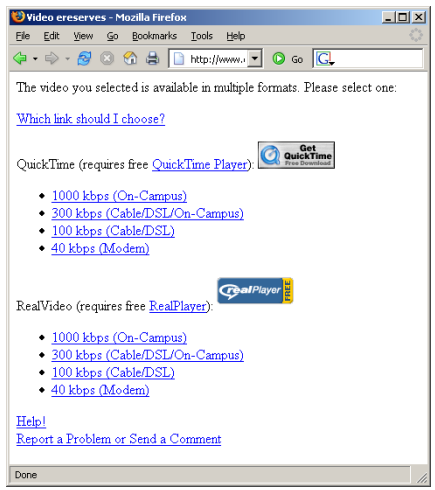

course number

eres password

DAAP: Digital Audio Archives Project

- IMLS-funded partnership:
  - Johns Hopkins University Digital Knowledge Center
  - IU Digital Library Program
  - IU Cook Music Library
  - IU School of Music
- October 2004 - September 2006
- R&D: Workflow for efficient high-quality audio digitization
- Digitizing items from School of Music performance archive

Sound Directions

- NEH-funded partnership:
  - IU Archives of Traditional Music
  - Harvard Loeb Music Library
  - IU Digital Library Program
  - Harvard University Library OIS
- Research and development:
  - Best practices for digital audio preservation
  - Creation of interoperable audio preservation packages
- http://www.dlib.indiana.edu/projects/sounddirections/

Questions?

- Jon Dunn: jwd@indiana.edu
- Jenn Riley: jenlrile@indiana.edu

- http://www.dlib.indiana.edu/workshops/bbspring2005.htm

- *Thanks to Jerry McDonough of NYU!*